

## IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Nuri R. Dagdeviren

Serial No.: 09/540,475

Filed: March 31, 2000

Title: PRECODING FOR A NON-LINEAR CODEC

Grp./A.U.: 2637

Examiner: Young Toi Tse

Confirmation No.: 2477

Commissioner for Patents  
P.O. Box 1450  
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Sir:

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**SUPPLEMENTAL AMENDMENT UNDER 37 C.F.R. § 1.111**

The Applicants previously submitted a response on February 9, 2007, to the Examiner's Action mailed November 9, 2006. In a Notice of Non-Compliant Amendment mailed on May 14, 2007, the Examiner indicated that the response did not comply with 37 C.F.R. 1.121. Accordingly, the Applicants submit this Supplemental Amendment to show that claims 8, 9, 21, 22, 55, 56, 73, 85, 92, 96, 98, 103, 108, and 109 are now amended to address the rejection. No other changes have been made to the previously filed amendment. The Applicants, therefore, respectfully request reconsideration of this application in view of the following amendment and remarks.

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**AMENDMENT UNDER 37 C.F.R. § 1.111**

The Applicant has carefully considered this application in connection with the Examiner's Action mailed November 9, 2006, and respectfully requests reconsideration of this application in view of the following amendment and remarks.

**IN THE SPECIFICATION:**

Please replace the paragraph that begins on page 8, line 11, with the following paragraph showing changes.

The levels in the exemplary table 30 can also be subdivided into three separate constellations: a basic constellation 42, a positive constellation 44, and a negative constellation 46.

The basic constellation 42 extends into both the positive and negative directions from an amplitude level of zero. Typically, the basic constellation extends an equal distance from amplitude zero into both the positive and negative directions. The positive constellation 44 extends from the maximum level of the basic constellation upwards, and the negative constellation 46 extends from the minimum level of the basic constellation downwards. For example, as shown in FIG. 2, the basic constellation includes the amplitudes  $\{2, 1, -1, -2\}$ , or alternatively the basic constellation includes the indexes  $\{2, 1, -1, -2\}$ . The positive constellation includes the amplitudes  $\{3, 5, 7, 9\}$  or the indexes  $\{3, 4, 5, 6\}$ . The negative constellation includes the amplitudes  $\{-3, -5, -7, -9\}$  or the indexes  $\{-3, -4, -5, -6\}$ . In a preferred embodiment of the invention, the basic constellation includes a set of indexes extending from  $-k$  to  $k$ ; the positive constellation includes a set of indexes indiees extending from  $k+1$  to  $3k$ ; and the negative constellation includes a set of indexes indiees extending from  $-k-1$  to  $-3k$ .

**IN THE CLAIMS:**

1. (Previously Presented) A precoder for generating a mapped constellation signal, from an input signal, comprising:

a feedback filter, based upon a model of an impulse response of a communication channel, that generates a feedback signal as a function of the mapped constellation signal, and

a processing element that generates the mapped constellation signal from the input signal and the feedback signal, the processing element utilizing an index to a constellation of levels chosen for the precoder, wherein the constellation of levels includes a basic constellation of levels and a set of levels outside the basic constellation of levels, such that the amplitude of the mapped constellation signal is limited.

2. (Previously Presented) The precoder according to claim 1, wherein the processing element comprises:

an adder that adds together the feedback signal and the input signal to generate a partial result, and

a mapper that generates the mapped constellation signal by mapping the partial result outside the basic constellation of levels onto the basic constellation of levels as a function of the index to the constellation of levels for the precoder.

3. (Original) The precoder according to claim 1, wherein the feedback filter includes a delay element and a weighting element such that the feedback filter multiplies a delayed version of the mapped constellation signal by the weighting element to generate the feedback signal.

4. (Canceled)

5. (Currently Amended) The precoder according to claim 2, wherein the mapper comprises:

a table identifying the basic constellation of levels and a mapping from the set of levels outside the basic constellation of levels to levels inside the basic constellation of levels.

6. (Currently Amended) The precoder according to claim 1, wherein each of the set of levels outside the basic constellation of levels is mapped onto only one level inside the basic constellation of levels.

7. (Currently Amended) The precoder according to claim 2, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from 1-k to k, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index positive\_const, where the positive\_const goes from k+1 to m, associated with a plurality of levels outside the basic constellation of levels, wherein said k is a constant and said m is a multiple of said k.

8. (Currently Amended) The precoder according to claim 7, wherein each of the plurality of levels outside the basic constellation of levels index are mapped onto a level inside the basic constellation of levels according to the equation:

index positive\_const  $\rightarrow$  positive\_const  $[[ - ] ] \_ (2 * k)$ ; while positive\_const  $> m - k$ ; and

index positive\_const  $\rightarrow$  positive\_const  $[[ - ] ] \_ (2 * k) - 1$ ; while positive\_const  $\leq m - k$ ;

wherein  $\rightarrow$  identifies a the mapping function.

9. (Currently Amended) The precoder according to claim 2, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from -k to k  
-1 to k, associated with each of a plurality of levels inside the basic constellation of levels, and  
 having a constellation index negative\_const, where the negative\_const goes from -k-1 to -m,  
 associated with a plurality of levels outside the basic constellation of levels.

10. (Currently Amended) The precoder according to claim 9, wherein each of the  
 plurality of levels outside the basic constellation of levels index are mapped onto a level inside  
 the basic constellation of levels according to the equation:

index negative\_const  $\rightarrow$  negative\_const +  $(2*k)$ ; while negative\_const  $< -(m-k)$ ; and

index negative\_const  $\rightarrow$  negative\_const +  $(2*k)+1$ ; while negative\_const  $> -(m-k)$ ;

wherein  $\rightarrow$  identifies a ~~the~~ mapping function.

11. (Original) The precoder according to claim 7, wherein the mapper further comprises  
 a comparator for comparing the partial result with the levels in the table.

12. (Original) The precoder according to claim 11; wherein the comparator identifies the  
 level closest to the partial result.

13. (Currently Amended) The precoder according to claim 12, wherein a ~~the~~ mapper  
 further includes an output block that generates a ~~the~~ mapped constellation signal equal to a level  
 inside the basic constellation of levels, if the identified level in the table closest to the partial  
 result is inside the basic constellation of levels.

14. (Currently Amended) The precoder according to claim 13, wherein the ~~output block~~ includes a ~~summer for adding~~ mapped constellation signal is set equal to the sum of the partial result and a mapping distance signal, wherein the mapping distance signal equals the distance between the index basic\_const, ~~associated~~ ~~associate~~ with the basic constellation level of the input signal, and the index positive\_const, associated with a level outside the basic constellation of levels.

15. (Original) The precoder according to claim 1, further comprising a digital to analog converter that generates an analog output signal based upon the mapped constellation signal.

16. (Previously Presented) The precoder according to claim 15, further comprising a hybrid for operably coupling the digital to analog converter to an analog subscriber loop.

17. (Currently Amended) The precoder according to claim 1, wherein successive levels in the basic constellation of levels are separated by a distance D1, and wherein a plurality of successive levels outside the basic constellation of levels are is separated by a distance D2 such that D1 differs from D2.

18. (Currently Amended) A precoder for an analog modem, the precoder comprising:  
a processing element that generates ~~a~~the mapped constellation signal as a function of a feedback signal and an input signal to the precoder, the processing element including:

an adder that adds together the feedback signal and the input signal to generate a partial result,

a table identifying a basic constellation of levels and levels outside the basic constellation of levels, wherein the levels outside the basic constellation of levels are mapped onto levels

inside the basic constellation of levels as a function of an index associated with each level in the table,

an output block that generates a mapped constellation signal equal to a level inside the basic constellation of levels by mapping a partial result outside the basic constellation of levels onto a level inside the basic constellation of levels, and

a feedback filter that generates the feedback signal as a function of the mapped constellation signal output by the processing element.

19. (Currently Amended) The precoder according to claim 18, wherein each of the levels outside the basic constellation of levels in the table ~~are~~is mapped onto only one level inside the basic constellation of levels in the table.

20. (Currently Amended) The precoder according to claim 18, further comprising:  
~~at the~~ table having a constellation index basic\_const, where ~~the~~ basic\_const goes from ~~1-k~~ to k, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index positive\_const, where ~~the~~ positive\_const goes from k+1 to m, associated with a plurality of levels outside the basic constellation of levels.

21. (Currently Amended) The precoder according to claim 20, wherein each of the plurality of levels outside the basic constellation of levels index ~~are~~is mapped onto a level inside the basic constellation of levels according to the equation:

index positive\_const  $\rightarrow$  positive\_const  $[(\_) - (2*k)]$ ; while positive\_const  $> m-k$ ; and

index positive\_const  $\rightarrow$  positive\_const  $-(2*k)-1$ ; while positive\_const  $\leq m-k$ ;

wherein  $\rightarrow$  identifies ~~a~~ the mapping function.



22. (Currently Amended) The precoder according to claim 18, further comprising:

~~a~~the table having a constellation index basic\_const, where the basic\_const goes from ~~-1k~~ to  $[-1]k$ , associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index negative\_const, where the negative\_const goes from  $-k-1$  to  $-m$ , associated with a plurality of levels outside the basic constellation of levels.

23. (Currently Amended) The precoder according to claim 22, wherein each of the plurality of levels outside the basic constellation of levels index ~~are~~is mapped onto a level inside the basic constellation of levels according to the equation:

$\text{index negative\_const} \rightarrow \text{negative\_const} + (2 * k)$ ; while  $\text{negative\_const} < -(m - k)$ ; and

$\text{index negative\_const} \rightarrow \text{negative\_const} + (2 * k) + 1$ ; while  $\text{negative\_const} \geq -(m - k)$ ;

wherein  $\rightarrow$  identifies ~~a~~ the mapping function.

24. (Currently Amended) The precoder according to claim 20, wherein the ~~output block~~ includes a summer for adding mapped constellation signal is set equal to the sum of the partial result and a mapping distance signal, wherein the mapping distance signal equals the distance between the index basic\_const, associated with the basic constellation level of the input signal, and the index positive\_const, associated with a level outside the basic constellation of levels.

25. (Previously Presented) A method of precoding an input signal to generate a mapped constellation signal, comprising:

generating a feedback signal from the mapped constellation signal by multiplying a delayed version of the mapped constellation signal by a weighting element, and

performing an operation on the feedback signal and the input signal based upon an index to a constellation of levels chosen for a precoder, wherein the constellation of levels includes a basic constellation of levels and a set of levels outside the basic constellation of levels, such that an amplitude of the mapped constellation signal is limited.

26. (Previously Presented) The method of precoding according to claim 25, wherein the step of performing the operation includes:

adding together the input signal and the feedback signal to generate a partial result,  
determining whether the generated partial result is contained within the basic constellation of levels, and

generating the mapped constellation signal by mapping a partial result outside the basic constellation of levels onto a level inside the basic constellation of levels as a function of the index to the constellation of levels for the precoder.

27. (Canceled)

28. (Currently Amended) The method according to claim 26, wherein the determining step further includes comparing the generated partial result with a table identifying the basic constellation of levels and a plurality of levels outside the basic constellation of levels.

29. (Currently Amended) The method according to claim 28, ~~further including generating a~~ wherein the generated mapped constellation signal equals equal to the partial result if the partial result is inside the basic constellation of levels.

30. (Currently Amended) The method according to claim 28, further including the step of determining whether the partial result is less than ~~the a~~ minimum level of the basic

constellation of levels or whether the partial result is greater than a maximum level of the basic constellation of levels.

31. (Currently Amended) The method according to claim 30, further including a step of determining a mapping distance  $p_j$  when the partial result is less than the minimum level of the basic constellation of levels, the mapping distance  $p_j$  being equal to a distance between an index basic\_const, associated with ~~the~~a basic constellation level of the input signal, and an index positive\_const, associated with a level outside the basic constellation of levels, wherein said j represents said basic constellation level of the input signal and said level outside the basic constellation of levels.

32. (Currently Amended) The method according to claim 31, wherein the index positive\_const is an index to a level that maps onto the basic constellation level of the input signal, and wherein the index positive\_const is an index to a level in a positive constellation of levels that includes those levels greater than the maximum in the basic constellation of levels.

33. (Previously Presented) The method according to claim 32, further including a step of obtaining the index positive\_const from a table.

34. (Currently Amended) The method according to claim 31, further including a step of generating a~~the~~ mapped constellation signal by adding together the partial result and the mapping distance  $p_j$ .

35. (Currently Amended) The method according to claim 30, further including a step of determining a mapping distance  $n_j$ , when the partial result is greater than the maximum level of the basic constellation of levels, the mapping distance  $n_j$  being equal to a distance between an

index basic\_const, associated with ~~the~~ basic constellation level of the input signal, and an index negative\_const, associated with a level outside the basic constellation of levels, wherein  $j$  represents said basic constellation level of the input signal and said level outside the basic constellation of levels.

36. (Currently Amended) The method according to claim 35, wherein the index negative\_const is an index to a level that maps onto the basic constellation level of the input signal, and wherein the index negative\_const is an index to a level in a negative constellation of levels that includes those levels less than the minimum level in the basic constellation of levels.

37. (Original) The method according to claim 36, further including the step of obtaining the index negative\_const from a table.

38. (Currently Amended) The method according to claim 35, further including the step of generating ~~a~~the mapped constellation signal by adding together the partial result and the mapping distance  $n_j$ .

39. (Previously Presented) A computer-readable medium having stored thereon a plurality of instructions, the plurality of instructions including instructions that when executed by a processor cause the processor to implement a method of precoding an input signal to generate a mapped constellation signal, the method comprising:

generating a feedback signal from the mapped constellation signal, and

performing an operation on the feedback signal and the input signal based upon an index to a constellation of levels chosen for a precoder, wherein the constellation of levels includes a

basic constellation of levels and a set of levels outside the basic constellation of levels, such that an amplitude of the mapped constellation signal is limited, the performing including:

adding together the input signal and the feedback signal to generate a partial result,  
determining whether the generated partial result is contained within the basic constellation of levels, and

generating the mapped constellation signal by mapping a partial result outside the basic constellation of levels onto a level inside the basic constellation of levels.

40. (Canceled)

41. (Previously Presented) The precoder according to claim 1 wherein the amplitude of the mapped constellation signal is limited to the basic constellation of levels.

42. (Previously Presented) The precoder according to claim 18 wherein a first distance between successive levels in the basic constellation of levels differs from a second distance between successive levels outside the basic constellation of levels.

43. (Previously Presented) The method according to claim 25 wherein the step of performing includes limiting the amplitude of the mapped constellation signal by the basic constellation of levels.

44. (Previously Presented) The method according to claim 25 wherein a first distance between successive levels in the basic constellation of levels differs from a second distance between successive levels outside the basic constellation of levels.

45. (Previously Presented) The method according to claim 25 wherein the step of performing includes mapping each level outside the basic constellation of levels onto only one level inside the basic constellation of levels.

46. (Previously Presented) The computer-readable medium of claim 39 wherein the amplitude of the mapped constellation signal is limited to the basic constellation of levels.

47. (Previously Presented) The computer-readable medium of claim 39 wherein a first distance between successive levels in the basic constellation of levels differs from a second distance between successive levels outside the basic constellation of levels.

48. (Previously Presented) The computer-readable medium of claim 39 wherein the step of performing includes mapping each level outside the basic constellation of levels onto only one level inside the basic constellation of levels.

49. (Currently Amended) An apparatus for generating a mapped constellation signal from an input signal, comprising:

a precoder configured to generate the mapped constellation signal from the input signal and a feedback signal using a constellation of levels that includes a basic constellation of levels having successive levels that are separated by a distance  $D1$  and a set of levels outside the basic constellation of levels wherein a plurality of successive levels outside the basic constellation of levels are is separated by a distance  $D2$  such that  $D1$  differs from  $D2$ , and wherein the precoder is configured to associate an index with each of the levels in the constellation of levels such that the levels outside the basic constellation of levels are associated with the levels inside the basic constellation of levels.

50. (Previously Presented) The apparatus according to claim 49 further including a feedback filter having a delay element and a weighting element such that the feedback filter multiplies a delayed version of the mapped constellation signal by the weighting element to generate the feedback signal.

51. (Currently Amended) The apparatus according to claim 49 further including a feedback filter coupled to said precoder and based upon a model of an impulse response of a communication channel.

52. (Currently Amended) The apparatus according to claim 49 wherein the precoder employs an adder that adds together the feedback signal and the input signal to generate a partial result and a mapper that generates the mapped constellation signal by mapping a partial result outside the basic constellation of levels onto the basic constellation of levels as a function of the index to the constellation of levels, the mapper having a table to identify the basic constellation of levels and associate levels outside the basic constellation of levels to levels inside the basic constellation of levels.

53. (Currently Amended) The apparatus according to claim 49 wherein each of the levels outside the basic constellation of levels ~~are~~ only associated with one level inside the basic constellation of levels.

54. (Currently Amended) The apparatus according to claim 49 ~~further comprising~~ wherein the precoder includes a table that identifies the basic constellation of levels, wherein the table has a constellation index `basic_const`, where the `basic_const` goes from  $\pm k$  to  $k$ , associated with each of a plurality of levels inside the basic constellation of levels, and wherein the

~~precode~~table has a constellation index positive\_const, where the positive\_const goes from  $k+1$  to  $m$ , associated with a plurality of levels outside the basic constellation of levels, wherein said  $k$  is a constant and said  $m$  is a multiple of said  $k$ .

55. (Currently Amended) The apparatus according to claim 54 wherein the precoder maps each of the plurality of levels outside the basic constellation of levels index onto a level inside the basic constellation of levels according to the equation:

index positive\_const  $\rightarrow$  positive\_const  $[-] - (2*k)$ ; while positive\_const  $> m-k$ ; and

index positive\_const  $\rightarrow$  positive\_const  $[-] - (2*k) - 1$ ; while positive\_const  $\leq m-k$ ;

wherein  $\rightarrow$  identifies a the mapping function.

56. (Currently Amended) The apparatus according to claim 49 further comprising a table the precoder that identifies the basic constellation of levels, wherein the table has a constellation index basic\_const, where the basic\_const goes from  $-k$  to  $k$   $[-1$  to  $-k]$ , associated with each of a plurality of levels inside the basic constellation of levels, and wherein the ~~precode~~table has a constellation index negative\_const, where the negative\_const goes from  $-k-1$  to  $-m$ , associated with a plurality of levels outside the basic constellation of levels, wherein said  $k$  is a constant and said  $m$  is a multiple of said  $k$ .

57. (Currently Amended) The apparatus according to claim 56 wherein the precoder maps each of the plurality of levels outside the basic constellation of levels index onto a level inside the basic constellation of levels according to the equation:

index negative\_const  $\rightarrow$  negative\_const  $+ (2*k)$ ; while negative\_const  $< -(m-k)$ ; and

index negative\_const  $\rightarrow$  negative\_const  $+ (2*k) + 1$ ; while negative\_const  $\geq -(m-k)$ ;



wherein → identifies a the mapping function.

58. (Previously Presented) The apparatus according to claim 52 wherein the mapper further comprises a comparator for comparing the partial result with the levels in the table.

59. (Previously Presented) The apparatus according to claim 58 wherein the comparator identifies the level closest to the partial result.

60. (Currently Amended) The apparatus according to claim 59 wherein the mapper further includes an output block that generates at the mapped constellation signal equal to a level inside the basic constellation of levels, if the identified level in the table closest to the partial result is inside the basic constellation of levels.

61. (Currently Amended) The apparatus according to claim 60, wherein the ~~output block~~ includes a summer for adding mapped constellation signal is set equal to the sum of the partial result and a mapping distance signal, wherein the mapping distance signal equals the distance between the index basic\_const, associated with ~~the~~ a basic constellation level of the input signal, and the index positive\_const, associated with a level outside the basic constellation of levels.

62. (Canceled)

63. (Currently Amended) The apparatus according to claim 49 wherein a plurality of index values ~~are~~ is associated, respectively, with a plurality of amplitude levels in the constellation of levels.

64. (Currently Amended) The precoder according to claim 1 wherein a plurality of index values ~~are~~ is associated, respectively, with a plurality of amplitude levels in the constellation of levels.

65. (Currently Amended) The precoder according to claim 18 wherein a plurality of index values ~~are~~is associated, respectively, with a plurality of amplitude levels in ~~a~~ the constellation of levels.

66. (Currently Amended) The method of precoding according to claim 25 wherein a plurality of index values ~~are~~is associated, respectively, with a plurality of amplitude levels in the constellation of levels.

67. (Currently Amended) The computer-readable medium of claim 39 wherein a plurality of index values ~~are~~is associated, respectively, with a plurality of amplitude levels in the constellation of levels.

68. (Previously Presented) A precoder for generating a mapped constellation signal, from an input signal, comprising:

a feedback filter, including a delay element and a weighting element, that generates a feedback signal as a function of the mapped constellation signal by multiplying a delayed version of the mapped constellation signal by the weighting element, and

a processing element that generates the mapped constellation signal from the input signal and the feedback signal, the processing element utilizing an index to a constellation of levels chosen for the precoder, wherein the constellation of levels includes a basic constellation of levels and a set of levels outside the basic constellation of levels, such that the amplitude of the mapped constellation signal is limited.

69. (Previously Presented) The precoder according to claim 68, wherein the processing element comprises:

an adder that adds together the feedback signal and the input signal to generate a partial result, and

a mapper that generates the mapped constellation signal by mapping a partial result outside the basic constellation of levels onto the basic constellation of levels as a function of the index to the constellation of levels for the precoder.

70. (Currently Amended) The precoder according to claim 69, wherein the mapper ~~further~~ comprises:

a table identifying the basic constellation of levels and a mapping from the set of levels outside the basic constellation of levels to levels inside the basic constellation of levels.

71. (Currently Amended) The precoder according to claim 68, wherein each of the levels outside the basic constellation of levels is mapped onto only one level inside the basic constellation of levels.

72. (Currently Amended) The precoder according to claim 69, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from 1-k to k, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index positive\_const, where the positive\_const goes from k+1 to m, associated with a plurality of levels outside the basic constellation of levels.

73. (Currently Amended) The precoder according to claim 69, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from  $-k$  to  $[[(-)]k$  basic\_const goes from  $-1$  to  $-k$ , associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index negative\_const, where the negative\_const goes from  $-k-1$  to  $-m$ , associated with a plurality of levels outside the basic constellation of levels.

74. (Previously Presented) The precoder according to claim 72, wherein the mapper further comprises a comparator for comparing the partial result with the levels in the table.

75. (Previously Presented) The precoder according to claim 74, wherein the comparator identifies the level closest to the partial result.

76. (Currently Amended) The precoder according to claim 75, wherein the mapper further includes an output block that generates athe mapped constellation signal equal to a level inside the basic constellation of levels, if the identified level in the table closest to the partial result is inside the basic constellation of levels.

77. (Previously Presented) The precoder according to claim 68, further comprising a digital to analog converter that generates an analog output signal based upon the mapped constellation signal.

78. (Previously Presented) The precoder according to claim 77, further comprising a hybrid for operably coupling the digital to analog converter to an analog subscriber loop.

79. (Currently Amended) The precoder according to claim 68 wherein a plurality of index values areis associated, respectively, with a plurality of amplitude levels in the constellation of levels.

80. (Currently Amended) A precoder for generating a mapped constellation signal, from an input signal, comprising:

a feedback filter that generates a feedback signal as a function of the mapped constellation signal, and

a processing element that generates the mapped constellation signal from the input signal and the feedback signal, the processing element utilizing an index to a constellation of levels chosen for the precoder, wherein the constellation of levels includes a basic constellation of levels having successive levels separated by a distance  $D1$  and a set of levels outside the basic constellation of levels wherein a plurality of successive levels outside the basic constellation are separated by a distance  $D2$  such that  $D1$  differs from  $D2$ , such that the amplitude of the mapped constellation signal is limited.

81. (Previously Presented) The precoder according to claim 80, wherein the processing element comprises:

an adder that adds together the feedback signal and the input signal to generate a partial result, and

a mapper that generates the mapped constellation signal by mapping a partial result outside the basic constellation of levels onto the basic constellation of levels as a function of the index to the constellation of levels for the precoder.

82. (Currently Amended) The precoder according to claim 81, wherein the mapper comprises:

a table identifying the basic constellation of levels and a mapping from the set of levels outside the basic constellation of levels to levels inside the basic constellation of levels.

83. (Currently Amended) The precoder according to claim 80, wherein each of the levels outside the basic constellation of levels is mapped onto only one level inside the basic constellation of levels.

84. (Currently Amended) The precoder according to claim 81, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from ~~1-k~~ to k, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index positive\_const, where the positive\_const goes from k+1 to m, associated with a plurality of levels outside the basic constellation of levels.

85. (Currently Amended) The precoder according to claim 81, wherein the mapper comprises:

a table having a constellation index basic\_const, where the basic\_const goes from ~~-1-k~~ to ~~[-]k~~ basic\_const goes from -1 to -k, associated with each of a plurality of levels inside the basic constellation of levels, and having a constellation index negative\_const, where the negative\_const goes from -k-1 to -m, associated with a plurality of levels outside the basic constellation of levels.

86. (Previously Presented) The precoder according to claim 84, wherein the mapper further comprises a comparator for comparing the partial result with the levels in the table.

87. (Previously Presented) The precoder according to claim 80, further comprising a digital to analog converter that generates an analog output signal based upon the mapped constellation signal.

88. (Previously Presented) The precoder according to claim 87, further comprising a hybrid for operably coupling the digital to analog converter to an analog subscriber loop.

89. (Currently Amended) The precoder according to claim 80 wherein a plurality of index values are associated, respectively, with a plurality of amplitude levels in the constellation of levels.

90. (Previously Presented) An apparatus for generating a mapped constellation signal from an input signal, comprising:

a feedback filter having a delay element and a weighting element such that the feedback filter multiplies a delayed version of the mapped constellation signal by the weighting element to generate a feedback signal, and

a precoder configured to generate the mapped constellation signal from the input signal and the feedback signal, wherein the precoder utilizes a constellation of levels that include a basic constellation of levels and a set of levels outside the basic constellation of levels, and wherein the precoder is configured to associate an index with each of the levels in the constellation of levels such that the levels outside the basic constellation of levels are associated with the levels inside the basic constellation of levels.

91. (Currently Amended) The apparatus according to claim 90 wherein each of the levels outside the basic constellation of levels ~~are~~is only associated with one level inside the basic constellation of levels.

92. (Currently Amended) The apparatus according to claim 90 further comprising a ~~table~~the precoder that identifies the basic constellation of levels, wherein the table has a constellation index basic\_const, where the basic\_const goes from -k to k ~~[[ -1 to -k]]~~, associated with each of a plurality of levels inside the basic constellation of levels, and wherein the ~~precoder~~table has a constellation index negative\_const, where the negative\_const goes from -k-1 to -m, associated with a plurality of levels outside the basic constellation of levels.

93. (Currently Amended) The apparatus according to claim 92 wherein ~~a~~ the mapper maps each of the plurality of levels outside the basic constellation of levels ~~index~~ onto a level inside the basic constellation of levels according to the equation:

index negative\_const  $\rightarrow$  negative\_const + (2\*k); while negative\_const  $\leq$  -(m-k); and

index negative\_const  $\rightarrow$  negative\_const + (2\*k)+1; while negative\_const  $\geq$  -(m-k);

wherein  $\rightarrow$  identifies ~~a~~ the mapping function.

94. (Currently Amended) The apparatus according to claim 90 wherein successive levels in the basic constellation of levels are separated by a distance D1, and wherein a plurality of successive levels outside the basic constellation of levels ~~are~~is separated by a distance D2 such that D1 differs from D2.



95. (Currently Amended) The apparatus according to claim 90 wherein a plurality of index values ~~are~~is associated, respectively, with a plurality of amplitude levels in the constellation of levels.

96. (Currently Amended) An apparatus for generating a mapped constellation signal from an input signal, comprising:

a feedback filter based upon a model of an impulse response of a communication channel that generates a feedback signal, and

a precoder configured to generate~~[[ ]]~~ the mapped constellation signal from the input signal and the feedback signal, wherein the precoder utilizes a constellation of levels that include a basic constellation of levels and a set of levels outside the basic constellation of levels, and wherein the precoder is configured to associate an index with each of the levels in the constellation of levels such that the levels outside the basic constellation of levels are associated with the levels inside the basic constellation of levels.

97. (Currently Amended) The apparatus according to claim 96 wherein each of the levels outside the basic constellation of levels ~~are~~is only associated with one level inside the basic constellation of levels.

98. (Currently Amended) The apparatus according to claim 96 further comprising a ~~table~~the precoder that identifies the basic constellation of levels, wherein the table has a constellation index basic\_const, where the basic\_const goes from -k to k ~~[[ -1 to -k ]]~~, associated with each of a plurality of levels inside the basic constellation of levels, and wherein the

~~precoder~~table has a constellation index negative\_const, where the negative\_const goes from -k-1 to -m, associated with a plurality of levels outside the basic constellation of levels.

99. (Currently Amended) The apparatus according to claim 96 wherein successive levels in the basic constellation of levels are separated by a distance D1, and wherein a plurality of successive levels outside the basic constellation of levels areis separated by a distance D2 such that D1 differs from D2.

100. (Currently Amended) The apparatus according to claim 96 wherein a plurality of index values areis associated, respectively, with a plurality of amplitude levels in the constellation of levels.

101. (Currently Amended) An apparatus for generating a mapped constellation signal from an input signal, comprising:

a precoder configured to generate the mapped constellation signal from the input signal and a feedback signal, wherein the precoder utilizes a constellation of levels that include a basic constellation of levels and a set of levels outside the basic constellation of levels, and wherein the precoder is configured to associate an index with each of the levels in the constellation of levels such that the levels outside the basic constellation of levels are associated with the levels inside the basic constellation of levels, and wherein the precoder employs an adder that adds together the feedback signal and the input signal to generate a partial result and a mapper that generates the mapped constellation signal by mapping a partial result outside the basic constellation of levels onto the basic constellation of levels as a function of the index to the constellation of

levels, the mapper having a table to identify the basic constellation of levels and associate levels outside the basic constellation of levels to levels inside the basic constellation of levels.

102. (Currently Amended) The apparatus according to claim 101 wherein each of the levels outside the basic constellation of levels are only associated with one level inside the basic constellation of levels.

103. (Currently Amended) The apparatus according to claim 101 wherein the precoder includes a table that identifies the basic constellation of levels, wherein the table has a constellation index basic\_const, where the basic\_const goes from -k to k  $[[ -1 \text{ to } -k ]]$ , associated with each of a plurality of levels inside the basic constellation of levels, and wherein the ~~precoder~~ table has a constellation index negative\_const, where the negative\_const goes from -k-1 to -m, associated with a plurality of levels outside the basic constellation of levels.

104. (Currently Amended) The apparatus according to claim 101 wherein successive levels in the basic constellation of levels are separated by a distance D1, and wherein a plurality of successive levels outside the basic constellation of levels are separated by a distance D2 such that D1 differs from D2.

105. (Currently Amended) The apparatus according to claim 101 wherein a plurality of index values are associated, respectively, with a plurality of amplitude levels in the constellation of levels.

106. (Currently Amended) An apparatus for generating a mapped constellation signal from an input signal, comprising:

a precoder configured to generate the mapped constellation signal from the input signal and a feedback signal, wherein the precoder utilizes a constellation of levels that include a basic constellation of levels and a set of levels outside the basic constellation of levels, and wherein the precoder is configured to associate an index with each of the levels in the constellation of levels such that the levels outside the basic constellation of levels are associated with the levels inside the basic constellation of levels and the precoder employs a table that identifies the basic constellation of levels, the table having a constellation index basic\_const, where the basic\_const goes from  $1-k$  to  $k$ , associated with each of a plurality of levels inside the basic constellation of levels, and the precoder table having a constellation index positive\_const, where the positive\_const goes from  $k+1$  to  $m$ , associated with a plurality of levels outside the basic constellation of levels, wherein said  $k$  is a constant and said  $m$  is a multiple of said  $k$ .

107. (Currently Amended) The apparatus according to claim 106 wherein each of the levels outside the basic constellation of levels ~~are~~ only associated with one level inside the basic constellation of levels.

108. (Currently Amended) The apparatus according to claim 106 wherein the precoder maps each of the plurality of levels outside the basic constellation of levels ~~index~~ onto a level inside the basic constellation of levels according to the equation:

index positive\_const  $\rightarrow$  positive\_const  $[[ - ] - (2*k)$ ; while positive\_const  $> m-k$ ; and

index positive\_const  $\rightarrow$  positive\_const  $[[ - ] - (2*k) - 1$ ; while positive\_const  $\leq m-k$ ;

wherein  $\rightarrow$  identifies a the mapping function.

109. (Currently Amended) The apparatus according to claim 106 ~~further comprising~~  
wherein the table that identifies the basic constellation of levels, wherein the table has a the  
constellation index basic\_const, where the basic\_const goes from -k to k [[ -1 to -k]], associated  
with each of a the plurality of levels inside the basic constellation of levels, and wherein the  
~~preorder table~~ has a constellation index negative\_const, where the negative\_const goes from -k-1  
to -m, associated with a plurality of levels outside the basic constellation of levels.

110. (Currently Amended) The apparatus according to claim 109 wherein a the mapper  
maps each of the plurality of levels outside the basic constellation of levels index onto a level  
inside the basic constellation of levels according to the equation:

index negative\_const  $\rightarrow$  negative\_const + (2\*k); while negative\_const < -(m-k); and

index negative\_const  $\rightarrow$  negative\_const + (2\*k)+1; while negative\_const  $\geq$  -(m-k);

wherein  $\rightarrow$  identifies a the mapping function.

111. (Currently Amended) The apparatus according to claim 109 wherein a the mapper  
further comprises a comparator for comparing a partial result with the levels in the table.

112. (Previously Presented) The apparatus according to claim 111 wherein the  
comparator identifies the level closest to the partial result.

113. (Currently Amended) The apparatus according to claim 112 wherein the mapper  
further includes an output block that generates a the mapped constellation signal equal to a level  
inside the basic constellation of levels, if the identified level in the table closest to the partial  
result is inside the basic constellation of levels.

114. (Currently Amended) The apparatus according to claim 112, wherein the ~~output block includes a summer for adding~~ mapped constellation signal is set equal to the sum of the partial result and a mapping distance signal, wherein the mapping distance signal equals the distance between the index basic\_const, associated with the a basic constellation level of the input signal, and the index positive\_const, associated with a level outside the basic constellation of levels.

115. (Currently Amended) The apparatus according to claim 106 wherein successive levels in the basic constellation of levels are separated by a distance D1, and wherein a plurality of successive levels outside the basic constellation of levels ~~are~~ is separated by a distance D2 such that D1 differs from D2.

### **REMARKS/ARGUMENTS**

The Examiner has indicated that Claims 1-3, 15, 16, 25, 265, 39, 41, 43-48, 68, 69, 77, 78, and 90 are allowed. The Examiner has indicated that Claims 5-14, 17-24, 28-38, 49-61, 63-67, 70-76, 79-89 and 91-115 are objected to for informalities. Additionally, the Examiner has indicated that Claims 8, 10, 21, 23, 31-34, 51, 55, 57, 65, 93, 108 and 110-114 are rejected under 35 U.S.C. 112, second paragraph as being indefinite for failing to particularly point out and distinctly claim the subject matter of the invention. In response, the Applicant has amended the Claims to correct the informalities and antecedent basis problem. Accordingly, the Applicant respectfully asserts that all of the pending Claims 1-115 are now allowable.

#### **I. Formal Matters and Objections**

The Examiner has objected to Claims 5-14, 17-24, 28-38, 49-61, 63-67, 70-76, 79-89 and 91-115 due to informalities. In response, the Applicant has amended the Claims to correct the inadvertent errors and appreciates the Examiner's diligence in finding and bringing these errors to his attention. Accordingly, the Applicant requests the Examiner to withdraw the objection and allow issuance thereof.

#### **II. Rejection of Claims 8, 10, 21, 23, 31-34, 51, 55, 57, 65, 93, 108 and 110-114 under 35 U.S.C. §112**

The Examiner has rejected Claims 8, 10, 21, 23, 31-34, 51, 55, 57, 65, 93, 108 and 110-114 under 35 U.S.C. §112, second paragraph. In response, the Applicant has amended the Claims to

provide the correct antecedent basis for each claim. Accordingly, the Applicant respectfully requests the Examiner to withdraw the §112, second paragraph rejection with respect to these Claims and allow issuance thereof.

### III. Conclusion

In view of the foregoing amendment and remarks, the Applicant now sees all of the Claims currently pending in this application to be in condition for allowance and therefore earnestly solicits a Notice of Allowance for Claims 1-115.

The Applicant requests the Examiner to telephone the undersigned attorney of record at (972) 480-8800 if such would further or expedite the prosecution of the present application. The Commissioner is hereby authorized to charge any fees, credits or overpayments to Deposit Account 08-2395.

Respectfully submitted,

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